Mitigating the Threat of Lost Knowledge within Information Technology Departments

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Abstract

Experienced information technology professionals leaving an organization creates a risk of losing crucial knowledge. To mitigate this risk, an organization must identify key knowledge holders and develop a plan to transfer their knowledge before these employees leave the organization. This research develops the Knowledge Loss Assessment to identify employees with critical knowledge about important knowledge/skill areas within the IT department. We implemented the Knowledge Loss Assessment within an information technology department of a utility company which resulted in an actionable list of key knowledge holders and a prioritized list of knowledge and skills to transfer to other IT employees within the organization. The results of this study yielded several management principles for researchers and practitioners interested in mitigating the threat of lost knowledge within an information technology department.

1. Introduction

A problem facing many organizations is an aging IT workforce with employees that have had a long, rich history with the industry, organization, and IT department [1]. The ability to retain IT employees over a long tenure is often viewed as a benefit for the organization. Yet, the lengthy tenure of employees also creates "a double-edged sword" in that these long-tenured employees create a constraint for the organization by limiting the ability of the organization to replace the employees' knowledge when they leave the firm [2]. As these IT employees retire, the knowledge that leaves with them creates a vacuum among the employees left within the IT department. This is further exacerbated because many organizations have a limited ability to capture the knowledge of the approximate 10,000 baby boomers a day that are reaching retirement age [1].

On the surface, the importance of the loss of these employees is not obvious. After all, legacy technology can be replaced with new technology and the retiring employees can be replaced with new hires. Further, an organization has the ability to identify IT employees that are nearing retirement, so it seems reasonable to develop a plan to transfer knowledge before the employee retires. However, a deeper look reveals that these retiring workers are taking with them knowledge essential to the organization that cannot easily be replaced on the open market and can only be developed internally over a long period of time. Knowledge that is particularly challenging to transfer from retiring IT workers to new hires includes deep contextual knowledge related to embedded business process and how information systems are integrated [1]. Also included in this knowledge is understanding of where knowledge exists within the organization and how to access it. Many organizations are not prepared for the loss of this deep knowledge when these IT employees leave the organization [3].

The organization needs a succession plan to transfer both the technical and organizational knowledge to ensure knowledge is captured before retirement. There is a risk of lost knowledge if a proper succession plan is not in place. Yet, time pressures hinder knowledge transfer from retiring employees to other employees [4], particularly since those that are trying to learn this deep knowledge from their colleagues are doing so while still performing assigned duties. Many companies underestimate the importance of a structured succession plan for transferring knowledge [5]. Only half of the organizations surveyed by Deloitte and Touché made an effort to identify critical IT skills within their organization, and more than one-quarter of these organizations viewed identifying critical skills as unimportant [6]. Organizations that do recognize the need to identify critical knowledge possessed by IT employees before they retire lack a systematic approach to identify which knowledge is most critical and where to focus their efforts if multiple employees are nearing retirement.

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Unfortunately, there is a lack of research on age-related issues in the workforce and information systems [7]. Organizations, particularly those with an aging IT workforce, need directed strategies to aid in the transfer of key knowledge before employees retire and leave the organization. Yet, before knowledge can be transferred, it must first be identified and located. The primary objective of this research is to provide guidance to organizations and researchers about knowledge loss within their IT departments related to retiring employees. To accomplish this objective, this study offers two contributions. First, this research seeks to develop a process to identify individuals with specialized knowledge within the IT department based on the criticality of their knowledge/skills and their proximity to retirement. Once key knowledge-holders are identified, the organization is able to prioritize and focus efforts for knowledge transfer to minimize the risk of losing critical knowledge. Second, this research seeks to provide management principles for those interested in mitigating the risk of knowledge loss in an information systems department.

This research develops the Knowledge Loss Assessment which is a survey and analysis process to offer actionable advice to IT managers on the risk of technical, process, and other types of knowledge lost due to upcoming retirements. We begin by offering background information explaining the need for the Knowledge Loss Assessment. We then explain the Knowledge Loss Assessment, which was implemented within a utility company in the Midwestern United States. Finally, we present the results of the Knowledge Loss Assessment and discuss a series of management principles developed for use by academics or practitioners when considering the potential risk of lost knowledge within the IT department as a result of retiring personnel.

2. Background

As a result of the post WWII baby boom, a significant number of employees are retiring from the workforce. Unfortunately, the discussion of the impact of knowledge transfer from employee turnover focuses on employees leaving due to dissatisfaction with the organization [8-10], and not due to retirement. While knowledge transfer among dissatisfied employees is challenging, knowledge loss due to retirement possess a different risk for the organization [1].

IT employees leaving the organization due to retirement are taking with them deep contextualized knowledge of the systems, business processes and organization history developed over many years [1]. Many of these retiring employees are the same employees that developed and implemented systems that have been evolving within the organization for years. Their knowledge is more than understanding the technology or the coding used to create and maintain these systems. The IT employees that created these systems have knowledge of the business processes, integration points within the systems and organization, and institutional knowledge. These long tenured employees know more than just how the system works; they also know why the system was built and the manner in which the system was developed and modified over years or decades.

While some business and IT knowledge may be explicit, other components of the information systems are tacit and not easily transferred. Knowledge that is difficult to transfer within an organization is sometimes referred to as "sticky" [11]. There are many reasons why knowledge may be "sticky," such as if there is difficulty in identifying the cause and effect, if numerous exchanges are required between the knowledge holder and the knowledge recipient, if the knowledge recipient does not have a shared language and understanding with the knowledge holder, or if the knowledge recipient lacks motivation to obtain knowledge [12]. These challenges are manifested in IT departments, particularly when employees approaching retirement and there is a need to transfer knowledge within the department. For example, effective methods for troubleshooting and maintaining the information systems may only exist in the knowledge of the individuals who performed the work. Simply understanding the design and intended logic of an information system is not sufficient. Without understanding how code integrates with other systems or business processes, a fix to address one problem may create new issues with the system. Newer employees must learn how to conduct routine maintenance to keep the system running for operations within the organization. This knowledge evolves as the individual develops experience over time [13]. Furthermore, the retiring information systems workforce from the baby boomer generation possesses an "understanding of how technology, business processes, and systems have evolved in an organization" [13]. This knowledge is not easily codified, meaning it is difficult to transform this knowledge into traditional documentation such as best practices and manuals. The difficulty of transferring this mix of IT, process, organizational, and industry knowledge embedded in information systems makes it all the more important for organizations to identify and prioritize their efforts to transfer knowledge before the individuals that possess this knowledge retire. A further complication of transferring knowledge from retiring employees to other employees is that some

legacy systems may be viewed as uninteresting or irrelevant by newer IT employees who may not understand the value of these systems to the organization [1]. These systems might be written in languages that are not taught or are considered out of favor by younger IT employees, making it more difficult to find individuals that are willing to learn the knowledge held by those retiring.

This risk associated with the retirees' knowledge loss is further increased when the information systems are facing obsolescence. Many of the systems implemented and maintained by these experienced workers are legacy systems in need of replacement. Due to the obsolete technology and imprecise documentation of legacy systems, maintenance and migration of legacy software is "difficult, time consuming, and costly" [14, p. 600], requiring complex systems engineering work. For example, many skills used in legacy system development, such as mainframe programming, are no longer part of the skills set of newer employees [13]. More important, legacy systems have business logic embedded into the application code based on organizational routines [15]. This embedded business logic may only be understood by IT workers that have significant experience with the legacy system and deep contextual knowledge of the business and its processes [1]. Even if experienced IT workers are not aware of all the business logic, they may be the only individuals within the organization that possess the skills to research and troubleshoot the embedded business rules when problems arise or for developing scripts to test the new systems.

The loss of knowledge is an issue because traditional knowledge management activities such as documentation and knowledge repositories have limited effectiveness in practice. In particular, newer employees lack the context and shared knowledge to understand why organizational routines exists and the role of the information systems as part of the larger organization [16]. While some business and IT knowledge may be explicit, other components of the information systems are tacit and not easily transferred. For example, as new functionality is incorporated into legacy systems, IT employees less familiar with the system may not realize how new code impacts existing code and processes within the system. IT employees with a rich knowledge of the legacy system that also understand the evolution of the system throughout the organization's history have a greater appreciation of how different processes and procedures within the code are integrated and affect one another. These integration points, as well as the evolution of the system over time, can be challenging to document and extract from existing documentation and knowledge repositories.

The retiring information systems workforce from the baby boomer generation possesses an "understanding of how technology, business processes, and systems have evolved in an organization" [13]. This knowledge is not easily codified and transformed into traditional documentation such as best practices and manuals or into programming code. The difficulty of transferring this knowledge makes it all the more important for organizations to identify and prioritize their efforts to transfer knowledge before the individuals that possess this knowledge retire. Additionally, some of these legacy systems may be viewed as uninteresting or irrelevant by newer employees who may not understand the value of these systems to the organization [1].

The risk of this knowledge loss is particularly pressing for IT departments due to a convergence of three trends: "continued reliance on mainframe systems, an aging Baby Boomer population, and the limited skills base of younger IT workers" [17]. In some organizations, many individuals are facing similar time periods for retirement. It might not be feasible to transfer all knowledge leaving with those retiring; therefore, an organization needs to be able to prioritize which forms of knowledge loss leaves the organization most vulnerable. The risk is further increased by waiting till the employee is close to retirement because time pressures may impede knowledge transfer [5]. With retirement, the organization has advanced knowledge of the employee leaving the organization, making it much easier to plan for the transfer of knowledge from these critical employees - if the critical employees can be identified.

3. Research approach

To mitigate the risk of knowledge loss within IT departments due to retirements, we developed a process known as the Knowledge Loss Assessment to identify and prioritize the knowledge most at risk for loss within the IT department. The Knowledge Loss Assessment is comprised of 1) a survey completed by members of the IT department and 2) a data analysis approach to understand and interpret the data. The survey and analysis techniques identifies key knowledge holders within an organization and prioritizes the risk of knowledge loss in various areas based on input from both IT managers and members of the IT department.

The instrument and analysis approach was developed in cooperation with a utility company in the Midwestern United States. The utilities industry can be characterized as an industry with low turnover, an aging workforce, and aging legacy information

systems, all factors that make this industry at high risk of knowledge loss [18]. The case organization shares these qualities and has a diverse portfolio of information systems making it appropriate for our research. We had support from IT management at the organization, who participated in interviews for the development of the instrument. We first discuss the assessment instrument followed by the instrument analysis process.

3.1. Knowledge loss assessment survey

To develop the survey portion of the Knowledge Loss Assessment, we adapted a qualitative, multi-discipline, open-ended questionnaire created to identify critical knowledge in an organization [19-20]. We substantially altered the instrument to create a quantitative survey that allowed for new types of analysis techniques to prioritize the knowledge lost within an IT department. The alterations include converting the qualitative instrument to a web based instrument that collected quantitative data to identify key knowledge holders, their risk of retirement, and knowledge connectors within the organization. We provide a brief description of the instrument, but a detailed description of the Knowledge Loss Assessment survey is available from the authors.

The survey is comprised to two parts. Part I of the survey asks each respondent to identify co-workers that are relied upon for different types of knowledge to understand the different social networks within the IT department. Specifically, Part I identifies the employees' informal role within the greater social network [21-22] that may not be reflected in the organizational chart. It was designed to identify which co-workers were relied upon for different types of IT knowledge. In Part I, each employee identifies up to 10 co-workers that they seek out most often for knowledge, troubleshooting assistance, and discussion of innovative ideas. For each co-worker identified, the respondent identifies how frequently the co-worker was solicited based on a 5-point scale ranging from Very Frequently to Very Rarely. The purpose of this part of the survey is to understand the different types of social networks for IT knowledge within the organization.

Part II of the survey focuses on knowledge and skill areas within the IT department (e.g. Web Programming Languages, Database, Industry Knowledge). This part of the survey serves to prioritize the relative importance of particular knowledge and skills [19]. To develop this part of the survey, we conducted interviews with managers and employees at our case site to identify the IT knowledge/skill areas that were most relevant in their organization. These discussions with the IT department revealed fifteen standard IT knowledge areas such as Web Programming Languages, Database, and Industry Knowledge. The survey also allowed respondents to enter additional knowledge areas as needed.

The survey was designed for the respondents to rate each IT knowledge/skill area on several dimensions. First, the employee identifies the perceived threat of losing knowledge in the knowledge/skill area via a 4-point scale (None, Minimal, Moderate, Important). Next, the employee identifies how difficult it would be to transfer or share knowledge in that area also using a 4-point scale (Easy, Slightly Difficult, Moderately Difficult, Difficult). Then, for the knowledge/skill area, the employee identifies how feasible it would be to recover the knowledge area if it was lost using a 3-point scale (Very Feasible, Moderately Feasible, or Infeasible). Further, individuals had the option to identify up to three primary owners of each knowledge area as a means to identify the experts in each IT knowledge/skill area (Figure 2). Respondents also had the opportunity to "opt out" of evaluating a specific knowledge area if s/he did not have enough knowledge in the domain.

Managers at the organization solicited all 155 employees within the IT department to participate in the survey. 49 of 155 IT employees invited completed the survey instrument, representing a 32% response rate. This included responses from 10 of 21 managers (48% response rate) and 39 of 134 knowledge workers (29% response rate). Although we sought a higher level of participation among the IT employees within the organization, the number of responses was sufficient to provide insights to identify and prioritize knowledge among IT workers that was at risk of being lost within the organization.

3.2 Knowledge loss assessment analysis

The data collected through the Knowledge Loss Survey provides information the organization can use to identify individuals that are primary knowledge holders and to prioritize IT knowledge areas that are vulnerable to knowledge loss. Three of the analysis techniques allow an organization to identify which knowledge areas are most vulnerable to knowledge loss. One analysis technique identifies specific employees that are identified as the most knowledgeable within a specific knowledge area. The final analysis technique, social network analysis, can be applied to the data to identify individuals that are transfer hubs for knowledge within the IT department. Table 1 provides a brief description of each technique.

Analysis Technique	Definition	Purpose
Knowledge Loss Risk Analysis by Skill Area		
Retention Significance	Relative measure of the importance of each knowledge area within the organization	List of knowledge/skills prioritized based on relative importance of knowledge/skill
Attrition Risk	Assesses if an IT knowledge/skill area is at risk of loss by considering the likelihood of retirement for employees that are considered owners of each IT knowledge/skill area	List of knowledge/skills prioritized based on risk due to imminence of retirement of knowledge/skill holders
Knowledge Transfer Focus Rating	Identifies the knowledge area that represents the greatest risk for knowledge loss	List of knowledge/skills prioritized based on both relative importance of knowledge/skill and imminence of retirement of knowledge/skill holders
Knowledge Loss Risk Analysis by Employee		
Expert Attrition Risk	Identifies specific employees that are considered key knowledge owners for specific IT knowledge/skill areas and considers how soon the employee may retire.	List of employee experts for each knowledge/skill area prioritized by imminence of expert retirement
Social Network Analysis	Examines which employees are relied upon for different types of communication networks within the department	Representation of communication networks within the IT department and identification of people who serve as knowledge transfer hubs

Table 1: Data analysis techniques

The first analysis technique we developed is Retention Significance. Retention Significance is a relative measure of the importance of each knowledge area within the organization. Retention Significance is calculated for each IT knowledge/skill area by first summing, among all employees, the ratings for each factor: Loss Impact, Transfer Difficulty, and Recovery Feasibility. The totals for Loss Impact, Transfer Difficulty, and Recovery Feasibility are then summed again to identify the overall Retention Significance score for each knowledge area. The knowledge areas are sorted from highest to lowest based on the Retention Significance score. Higher scores suggest that the IT knowledge/skill area is more critical to retain within the organization.

Attrition Risk, the second analysis technique, assesses if an IT knowledge/skill area is at risk of loss by considering the retirement factors for employees that are listed as the owners of each IT knowledge/skill area. The Attrition Risk identifies which IT knowledge/skill areas are at risk based on the imminence of retirement for the owners of each IT knowledge/skill area.

The third analysis technique, the Knowledge Transfer Focus rating, identifies the knowledge area that represents the greatest risk for knowledge loss. The Knowledge Transfer Focus rating is calculated by multiplying each IT knowledge/skill area's Retention Significance by Attrition Risk. The Knowledge Transfer Focus rating takes into account both the relative importance of each IT knowledge/skill area based on the input of employees as well as the risk of losing knowledge in that area based on projected retirement among the owners of each knowledge area. Higher Knowledge Transfer Focus values suggest areas that should receive the most focus in knowledge transfer efforts.

The prior three analysis techniques identify IT knowledge/skill areas at risk for knowledge loss. However, the data provided by the IT Knowledge Loss Assessment Survey also enables the organization to identify individuals that have key knowledge within the organization and are likely to retire soon using the Expert Attrition Risk analysis technique. To calculate Expert Attrition Risk, one examines the number of times a person is identified as a knowledge/skill owner in an area. The number of times each person was identified as an owner for a particular knowledge/skill area was multiplied by their retirement factor to identify the Expert Attrition Risk for each expert in the area. All employees were then sorted in descending order based Expert Attrition Risk.

The information from IT Knowledge Loss Assessment Survey related to the frequency of communication between co-workers regarding knowledge, troubleshooting, and innovation and collected in Part I of the survey, can be used for social network analysis. The social network analysis identifies which employees are relied upon for the different types of communication networks: knowledge, troubleshooting, and innovation. This analysis identifies employees that facilitate important communication; however, these individuals may not appear as knowledge owners of an area or may be

overlooked if strictly the organizational chart or listings of specific expertise are taken into account.

4. Results

In this section we provide an overview the results of the Knowledge Loss Assessment by analysis technique. The first analysis technique is Retention Significance. Retention Significance is a relative measure of the importance of each knowledge/skills area within the organization and the analysis resulted in a prioritized list of IT knowledge/skill areas at the case organization. In general, the three values collected from the instrument (loss impact, transfer difficulty, and feasibility recovery), trended together. Certain core IT functions such as major applications, network, infrastructure, database, and servers ranked at the top of the list, indicating the importance of knowledge in these areas for the case organization.

The second technique is the Attrition Risk which assesses if an IT knowledge/skill area is at risk of loss by considering the retirement factors for employees listed as the owners of each IT knowledge/skill area. At the case organization, the IT knowledge/skill areas of data modeling and data warehouse, industry knowledge, and network were at greatest risk for attrition, while major applications and web programming languages were less vulnerable to upcoming retirements.

The Retention Significance analysis and the Attrition Risk analysis were combined to form the Knowledge Transfer Focus rating. The Knowledge Transfer Focus rating prioritizes knowledge/skill areas not only by the importance of the knowledge/skill to the IT department, but also by the imminence of the loss of the key knowledge holders. IT knowledge/skill areas highest on this list should have the highest priority for knowledge transfer efforts within the organization.

The results from the case organization indicate that although the network IT knowledge/skill area was not ranked highest for Retention Significance or Attrition Risk, considering both Retention Significance and Attrition Risk identified that the network IT knowledge/skill area should be a priority for knowledge transfer initiatives. In this organization, the knowledge and skills related to networking were highly concentrated among a few employees that were expected to retire in the near future, thus affecting the Knowledge Transfer Focus rating for this area. Other knowledge areas that demonstrate additional attention for knowledge transfer at this organization include database and industry knowledge.

A fourth analysis of the data, the Expert Attrition Risk focuses on individual employees by combining an employee's expected retirement date with the number of times they are mentioned as a knowledge/skill expert. The Expert Attrition Risk analysis identifies specific employees considered key knowledge owners for specific IT knowledge/skill areas and also considers the likelihood of retirement. At our case organization, two of the highly rated Transfer Focus areas (network and database) were analyzed further to identify which employees at the organization are recognized as having high levels of knowledge in the area and if these employees were close to retirement. This analysis identified that the network area relied heavily on two employees, while the database area had multiple knowledge owners. This finding provided value to the organization to help them realize that different strategies were needed to transfer knowledge among employees in the network area (with only two knowledge holders) versus the database area (with multiple knowledge holders).

Finally, a more sophisticated analysis was conducted using social network analysis. Drawing on data from Part I of the survey, information related to the frequency of communication between co-workers was analyzed to identify which employees are relied upon for different types of communication networks: knowledge, troubleshooting, and innovation. The social network analysis captured information flows and not specific knowledge/skills and thus highlighted key people that will leave a gap in communication within a group or among different groups in the organization upon their retirement or leaving the organization. Further, the social network analysis identified individuals that currently serve as knowledge transfer hubs. Several of these individuals were not initially identified by the organization as being key connectors of knowledge within the organization; however, once the individuals that serve as connectors retire, the employees' absence could create lapses in knowledge sharing among different groups of workers.

5. Discussion

After implementing the Knowledge Loss Assessment, we presented the results to managers at the case site to identify how well the artifact performed and to determine if the managers obtained new insights from the study. As part of this discussion with the managers and our review of the results, we developed a series of management principles related to assessing knowledge loss to guide organizations and researchers interested in mitigating the risk of lost knowledge within the IT department.

Prior to implementing the Knowledge Loss Assessment, the IT managers at the case organization

had opinions on the knowledge/skill areas that were most at-risk for knowledge loss due to upcoming retirements. The managers believed they knew which employees held valuable knowledge that needed to be transferred prior to their retirement. As a result of the Knowledge Loss Assessment, IT managers learned that some of their assumptions were inconsistent with the results of the assessment. For example, the analysis technique of Retention Significance identified new insights into the knowledge/skill areas that were at-risk for knowledge loss. The IT managers expected the knowledge/skill area representing enterprise data storage to be rated higher on the list. Prior to the Knowledge Loss Assessment, management viewed storage as an area in which knowledge loss would be a critical risk to the organization. The results suggested, however, that there was no general awareness of the importance of storage among those responding to the survey. These results provide an important insight: knowledge workers may view the criticality of knowledge/skill area differently than managers as a result of the differing responsibilities and perspectives among these groups.

It is important for managers to recognize that individuals at different levels of the organization may have differing insights as to what knowledge is important and who the key holders of this knowledge are. It is not that one group (i.e., employees or managers) are necessarily right or wrong, but each have a different understanding about the potential threat of knowledge loss in terms of how it impacts their role within the organization. Further, most attempts to capture knowledge leaving the organization are oriented towards explicit knowledge. However, it is the tacit knowledge that is most likely to get lost [23]. Given that tacit knowledge is more difficult to identify and transfer, it seems reasonable that groups of people within an organization with different tacit knowledge may have different insight into the nature of what is important knowledge and where it might exist in the organization and share different views on what is valuable. This leads to the first principle for assessing knowledge loss within an IT organization.

> *Principle #1: Managers and knowledge workers might have different views as to which knowledge is most at risk in the IT department; each perspective can offer insight to the organization about areas at risk for knowledge loss.*

The Transfer Focus analysis technique identified several areas that should be important to the case organization's knowledge retention efforts. In particular, the identification of networking as most important among the knowledge areas for Transfer Focus was unexpected by management. When reviewing the results of the Retention Significance and Attrition Risk calculations that led to the ranking, the IT managers determined that the results were appropriate. The analysis highlighted to management that the network area had a relatively high concentration of knowledge in a single individual that is expected to retire soon. The managers noted that they would have overlooked the critical knowledge held by this individual without the use of the Knowledge Loss Assessment.

While there has been extensive research on how to manage and transfer knowledge within organizations (e.g., [24-25]), less research has considered how to prioritize knowledge transfer efforts. While it might be ideal to transfer all knowledge, it is necessary to recognize that some knowledge might be more challenging to transfer and takes more time [11] or has a pressing deadline for knowledge transfer [1]. The rich, contextualized knowledge of older employees [7] can be valuable to share with newer employees, but may be challenging to share in traditional forms like documentation. By examining highly ranked knowledge areas in the manner allowed by the Knowledge Loss Assessment, the organization identified the concentration of knowledge for a specific knowledge domain. Domains in which the knowledge is highly concentrated (i.e., one or two knowledge owners) may need more attention to transfer the knowledge as compared to areas in which multiple people have overlapping knowledge of the domain. Considering the retirement factor also helps identify the threat of retirement among experts within these knowledge areas. Therefore, recognizing which knowledge is most pressing to transfer is critical both in terms of research and practice, which leads to the second principle.

> *Principle #2: Knowledge is particularly vulnerable to loss when there is a concentration of knowledge in a small number of experts within a specific domain.*

In addition to providing insights on important IT knowledge/skill areas, management learned about knowledge risks and identified knowledge transfer plans associated with specific employees using the Expert Attrition Risk and Social Network Analysis techniques. The instrument confirmed the expectations the IT managers had about some employees, but also provided new perspectives about other employees in the organization. For example, it was discovered that certain employees were not necessarily referenced as a specific knowledge/skill owner frequently, but these individuals were referenced frequently by others as a

source for information in the social network analysis portion of the survey. While these employees were not necessarily recognized as an expert within a knowledge domain, they were frequently referenced in other employees' communication networks as facilitating communication among employees. These employees were identified as being significant to promote knowledge sharing within the organization.

The use of the social network analysis highlighted that while identifying the knowledge and its key holders is necessary, it is also important to understand how that knowledge is transferred within the organization. Knowledge needs to be made available before it can be transferred [16, 26]. The identification of knowledge connectors can play an important role in making this information available to other employees, increasing the likelihood of transfer. Further, the transfer of knowledge in an organization is impacted by the strength of social relationships [27-28]. The strength of these relationships is particularly important when transferring tacit and complex information [27, 29, 30]. Given the importance of relationships on knowledge transfer, particularly complex, tacit knowledge, Cross et al [31] concludes that a broader group of "go-to" individuals should be developed in a firm to avoid the reliance on a few key individuals. Identifying which of the employees in these central communication roles are close to retirement and which ones are further from retirement can be helpful in developing strategies to ensure knowledge transfer efforts continue once individuals retire. Therefore, the third principle is:

> *Principle #3: Consider the risk of knowledge loss not only due to the retirement of key knowledge holders, but also knowledge connectors, when developing knowledge transfer strategies.*

Some employees were referenced frequently in both the social network portion of the survey and also as a knowledge/skill owner. During the presentation of the results, IT management anecdotally confirmed these findings, indicating that these were the employees that the managers themselves spoke with when they needed assistance or had questions. Although IT management agreed with the results, they were surprised that there was such a consensus among the employees that these individuals were seen as the "go to" individuals within the organization. Upon reflection, the IT managers noted that these employees were known as being approachable and able to solve problems, in large part due to their positions and personalities. The fact that these employees were recognized as experts and were central to the knowledge transfer network was likely a reflection of their firsthand knowledge, and their ability to readily access the knowledge of other experts when necessary.

Knowing that someone has information is not enough to motivate an individual to seek out knowledge and transfer it. The decision to seek out knowledge is impacted by the seeker's perceptions of the knowledge holder's expertise and whether that person will willingly share that expertise [32]. Andrews & Delahaye [33] found that approachability, credibility and trustworthiness of the source mediates the transfer process. Trust in the knowledge source is likewise essential to knowledge transfer [34]. The fact that the employees at our case site were recognized as experts and were central to the knowledge transfer network was likely a reflection of their reputation as being approachable and being able to access the information required. This leads to the final principle:

> *Principle #4: When creating strategies for knowledge transfer, consider the personal traits and skill levels of those that will be receiving that knowledge -- position and personality matter.*

This study brings to light many opportunities for additional research. To begin with there is a need for more research to study how these employees' knowledge can be effectively transferred. This is most important when the retiring employees have a wealth of knowledge – particularly contextual organizational knowledge. Second, while there are studies that discuss different aspects to transfer knowledge, there is less consideration of individual characteristics and the role personality plays in the transfer process. Research needs to explore the role of personality in connecting individuals with knowledge to the individuals who need to access that knowledge. Finally, we were surprised that knowledge we assumed to be difficult to replace such as business specific process and organizational routines did not score as high on the assessment. Research needs to explore what types of knowledge exists within the IT department and examine whether different types of knowledge are more difficult to replace.

6. Conclusion

This research addresses an important problem faced by many organizations - the loss of critical knowledge held by individuals within an IT department. There are a large number of individuals scheduled to leave the workforce due to retirement and these individuals represent not just knowledge related to the systems, but knowledge of the system integration points, business processes, and deep organizational and institutional

knowledge. While new employees can be hired and new technology can replace legacy systems, there is substantial knowledge that cannot easily be replaced. In order to minimize the risk of this knowledge loss, organizations need to be able to identify the most critical knowledge held by these individuals and plan for its transfer.

This research addresses this problem with the development of the Knowledge Loss Assessment. The Knowledge Loss Assessment consists of a survey that collects quantifiable data and a series of analysis techniques that offers actionable information to management. The Knowledge Loss Assessment is an improvement over prior knowledge retention assessment instruments because it is more comprehensive and enables multiple types of analyses to derive insights for the organization. The results of the Knowledge Loss Assessment provided a new perspective to IT management at the case organization by prioritizing the potential for lost knowledge in specific knowledge areas based on a comprehensive set of inputs for ratings. The detailed breakdowns of owners within a knowledge area, and knowledge areas by owner provided specific information that could be used to focus knowledge transfer efforts.

As with all research, this project has limitations to be aware of. To begin with, this instrument was targeted to the IT division of a utility company and the list of standard knowledge/skill areas reflects this focus. If this instrument structure and analysis is implemented with a focus other than IS, then it would be necessary to develop a standard set of knowledge/skill areas that is relevant to the industry or firm. Second, the 32% response rate is lower than IT management at the case company expected. In applications of the instrument outside of academic research, management should consider mandatory participation in order to achieve a higher response rate. Finally, this research was limited to prioritizing the needs for knowledge transfer based on the existing distribution of knowledge and relationships within a particular part of an organization. Further research opportunities are available to determine how best to proceed with knowledge transfer efforts at an organization once the needs have been identified.

This research also provides management principles to inform the understanding of assessing the potential of knowledge loss, based on the results of the artifact development. The first principle identifies that there are multiple perspectives on what information is most valuable and therefore who the key knowledge holders are. Second, the risk of knowledge loss is higher when knowledge is concentrated in a small number of individuals and this concentration makes it easier for management to overlook. Further, the network analysis revealed that it is not just the knowledge holders that are important, but the knowledge connectors who act as knowledge transfer points that management needs to be aware of. These individuals are important, not just because of what they know, but because of their personalities and strength of their relationships with others in the organization.

The Knowledge Needs Assessment and design principles resulting from this research can reduce the risk of this knowledge loss by providing actionable information to identify, prioritize and plan the transfer of this key knowledge before these individuals leave the firm. When those employees have a lengthy tenure with the firm, this provides great benefit to the firm. By taking specific steps to mitigate the potential for knowledge loss within the IT department, there is an opportunity to ensure a more seamless transition as workers retire and leave the IT organization.

9. References

[1] S. Petter and K. Ward, "Countdown to Y2Gray", IT Professional 15(6), 2013, pp. 49-55.

[2] U. Schultze and D. E. Leidner, "Studying Knowledge Management in Information Systems Research: Discourses and Theoretical Assumptions". MIS Quarterly, 26(3), 2002. pp. 213-242.

[3] D.W. DeLong, Lost Knowledge - Confronting the Threat of an Aging Workforce. New York, NY: Oxford University Press, 2004.

[4] S.Y. Lim, S.I. Jarvenpaa and H.J. Lanham, "Barriers to Interorganizational Knowledge Transfer in Post-Hospital Care Transitions: Review and Directions for Information Systems Research", Journal of Management Information Systems, 32(3), 2015, pp. 48-74.

[5] S. Xavier, "The Dark Side of the Retirement Bubble", Chief Learning Officer, May, 2009. pp.40-43.

[6] Deloitte and Touché. "Retiring Workforce, Widening Skills Gap, Exodus of 'Critical Talent' Threatens Companies". 2005.

[7] S. Tams, V. Grover and J. Thatcher, J. Modern Information Technology in an Old Workforce: Toward a Strategic Research Agenda. Journal of Strategic Information Systems, 2014, 23(4), 284-304.

[8] G. Ballinger, E. Craig, R. Cross and P. Gray, "A Stitch in Time Saves Nine: Leveraging Networks to Reduce the Cost of Turnover", California Management Review, 53(4), 2011, pp.111-133.

[9] T. Ferratt, R. Agarwal, C. Brown and J. Moore, "IT Human Resource Configurations and IT Turnover:

Theoretical Synthesis and Empirical Analysis", Information Systems Research 16(3), 2005, pp. 237-255.

[10] J.Jiang and G. Klein, "A Discrepancy Model of Information Systems Personnel Turnover", Journal of Management Information Systems, 19(2), 2002, 249-272.

[11] G. Szulanski. Exploring Internal Stickiness: Impediments to the Transfer of Best Practice Within the Firm. Strategic Management Journal, 1996, 17(S2), 27-43.

[12] G. Szulanski. The Process of Knowledge Transfer: A Diachronic Analysis of Stickiness. Organizational Behavior and Human Decision Processes, 2000, 82(1), 9-27.

[13] Hewitt, S. 2008. Defusing the Demographic Time-Bomb. Human Resource Management International Digest 16(7), 3-5.

[14] L. Wu, H. Sahraoui and P. Valtchev, "Coping with Legacy System Migration Complexity", IEEE International Conference on Engineering of Complex Computer Systems, 2005, pp. 600-6009

[15] S. Hildreth, "Rounding up Business Rules", Computerworld, May 23, 2005. http://www.computerworld.com/s/article/101844/Rounding_Up_Business_Rules?taxonomyId=18&pageNumber=2.

[16] T.H. Davenport and L. Prusak, Working Knowledge: How Organizations Manage What They Know. Boston: Harvard Business School Press, 1998.

[17] B. Koma, "The Incredible Shrinking Legacy Workforce", Optimize, August, 2003, pp. 56-66.

[18] M.J. Ashworth, "Preserving Knowledge Legacies: Workforce Aging, Turnover and Human Resource Issues in the US Electric Power Industry", International Journal of Human Resource Management, 17(9), 2006, pp. 1659-1688.

[19] B. Paladino, "Retaining Knowledge Capital. Business Finance", May, 2007, pp. 32-36.

[20] S.I. Trinkle The Nature of Tacit Knowledge and the Nature of the Expert: Tacit Knowledge Retention at the Tennessee Valley Authority. Unpublished Dissertation. 2005

[21] Cross, R., Parker, A. 2004. The Hidden Power of Social Networks. Boston, MA: Harvard Business School Press.

[22] S. Parise, R. Cross and T.H. Davenport, "Strategies for Preventing a Knowledge Loss Crisis", MIT Sloan Management Review, 47(4), 2006, pp. 31-38.

[23] C. Armistead and M. Meakins, "Managing Knowledge in Times of Organisational Change and Restructuring", Knowledge and Process Management 14(1), 2007, pp. 15-25.

[24] M. Alavi, D.E. Leidner, 2001. "Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues", MIS Quarterly 25(1), 2001, pp. 107-136.

[25] L. Markus, "Towards a Theory of Knowledge Reuse", Journal of Management Information Systems, 18(1), 2001. 57-93.

[26] L. Argote, Organizational Learning; Creating, Retaining, and Transfering Knowledge. Kluwer Academic Publishers, Norwell, MA. 1999.

[27] P. Byosiere, D.J. Luethge, A. Vas and M.P. Salmador, "Diffusion of Organizational Innovation: Knowledge Transfer Through Social Networks", International Journal of Technology Management 49(4), 2010, pp. 401-420.

[28] M. Granovetter, "The Strength of Weak Ties: A Network Theory Revisited", Sociological Theory, 1, 1983, pp. 201-233.

[29] M.T. Hansen, " The Search-Transfer Problem: The Role of Weak Ties in Sharing Knowledge Across Organization Subunits", Administrative Science Quarterly 44, 1999, pp. 82-111.

[30] R. Reagans and B. McEvily, 2003. "Network Structure and Knowledge Transfer: The Effects of Cohesion and Range", Administrative Science Quarterly 48, 2003, pp. 240-267.

[31] R. Cross, P. Gray, S. Cunningham, M. Showers and R.J. Thomas, "The Collaborative Organization: How to Make Employee Networks Really Work", MIT Sloan Management Review 52(1), 2010, pp. 83-90.

[32] S.P. Borgatti and R. Cross, 2003. "A Relational View of Information Seeking and Learning in Social Networks", Management Science 49(4), 432-445.

[33] K.M. Andrews, B.L. Delahaye, "Influences on Knowledge Processes in Organizational Learning", Journal of Management Studies 37, 2010, pp. 797-810.

[34] G. Szulanski, R. Cappetta and R.J. Jensen, 2004. "When and How Trustworthiness Matters: Knowledge Transfer and the Moderating Effect of Causal Ambiguity", Organization Science 15(5), 2004, pp. 600-613.